Abstracts of Papers

Thirtieth Annual Albert L. Tester Memorial Symposium, 16–18 March 2005[1]

The Albert L. Tester Memorial Symposium is held in honor of Professor Albert Tester, who, at the time of his death in 1974, was Senior Professor of Zoology at the University of Hawai'i at Mānoa. The faculty and students of the Department of Zoology proposed an annual symposium of student research papers as a means of honoring, in a continuing and active way, Dr. Tester's lively encouragement of student research in a broad range of fields within marine biology. Papers reporting original research on any aspect of science are solicited from students at the university and these papers are presented at the symposium, which takes place during the spring semester. Income from contributions to the Albert L. Tester Memorial Fund of the University of Hawai'i Foundation is used to provide prizes for the three best papers, judged on quality, originality, and importance of research reported, as well as the quality of the public presentation. Judges include Department of Zoology faculty members and the previous year's student award winners. In addition, a distinguished scholar from another university or research institution is invited to participate in the symposium as a judge and to present the major symposium address. In 2005 the distinguished visitor and judge was Dr. Stephen Palumbi, Stanford University, Hopkins Marine Station, Pacific Grove, California.

A Proposal to Study Connectance of Pollination Systems in Dry Forests of Hawai'i

Patrick Aldrich[2]

Traditionally, mutualistic plant-animal interactions have been placed in a dichotomy of specialized versus generalized relationships within a community. Recently ecologists have become aware that this split is artificial, and most systems are made up of connections and networks analogous to food webs. Using network theory and connectivity to describe species interactions can help explain the structural organization of the species richness of communities and how introduced pollinator species in the system can affect its stability. Hawaiian dry forests located at Pu'uwa'awa'a on the island of Hawai'i provide a system to study networks of native and introduced pollinators in a fragmented, altered landscape. Because most of the understory of the Hawaiian dry forests is a matrix of grasses, only the overstory trees will be used in this study. Observations will be made at inflorescences of all dominant tree species within the dry forest system. Each day a single species will be selected, based on phenology, and observed from sunrise to sunset. Data will be entered into a binary-coded matrix to examine interactions and connections between pollinators and plants. Analyses, following food web and network theory, will be used to test whether the connectivity is structured or random.

[1] Manuscripts accepted 29 July 2005.

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Ecological and Behavioral Factors Influencing Patterns of Interbreeding and Genetic Diversity in the Hawaiian Spinner Dolphin[3]

Kimberly R. Andrews[4]

In many cetacean populations, reproductively isolated subgroups exist within populations even when these subgroups live in the same geographic range or are capable of traveling to other subgroups' ranges. The factors that lead to reproductive isolation in these cetacean populations are often complex. For the Hawaiian spinner dolphin (*Stenella longirostris*), there is variability throughout the Hawaiian Archipelago in factors such as geographic distance between suitable habitat, prey distribution, habitat type and availability, population size, and social structure. To investigate whether these factors have led to reproductive isolation between subgroups and influenced genetic diversity, genetic structure and genetic diversity of the spinner dolphin throughout Hawai'i were investigated. Genetic samples were collected from Kure Atoll (34 samples), Midway Atoll (57), Pearl and Hermes Reef (21), French Frigate Shoals (13), Ni'ihau (39), O'ahu (47), Maui (60), and the Big Island (77). A 429–base pair region of the mitochondrial DNA (mtDNA) control region and 12 microsatellite loci were used to evaluate genetic structure and diversity. Analysis of molecular variance (AMOVA) indicated significant genetic structure for the spinner dolphin within Hawai'i for both mtDNA and microsatellites. The pattern of genetic structure could not be explained only by geographic distance between populations, indicating the presence of additional, more complex factors influencing patterns of interbreeding. An unexpected peak in genetic diversity was found at French Frigate Shoals, with an additional peak at the Big Island.

Species Biology of Yellow Tang, *Zebrasoma flavescens*, and Development of a Marine Protected Area Network

Jeremy Claisse[5]

Yellow tang, *Zebrasoma flavescens*, provides the largest aquarium fish catch in the state of Hawai'i, constituting 84% of all aquarium fish collected on the west coast of Hawai'i Island. Perceived declines of fish populations led to prohibiting aquarium collecting on more than 30% of this coast in 2000. Monitoring over the following 5 yr indicated that protection has substantially increased overall abundance of yellow tang and increased overall commercial catch. Despite the success of this Marine Protected Area (MPA) network, basic life history/species biology of this species remained relatively unknown. Over the past year, we have begun to examine age, growth, reproduction, movement, and habitat utilization for this species. Determination of size at first reproduction and initial aging results suggest that protection from fishing may affect population age structure markedly in this fishery where almost all individuals caught are prereproductive. Tagging and other means of individual identification indicate minimal movement of young individuals, association with certain habitat types, and relatively low mortality rates in protected areas. Such knowledge of the biology and ecology of this key species in this MPA network presents a unique opportunity to better understand the mechanics of MPA function and predict how the management of specific types and areas of coral reef habitat may affect fish populations.

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Initial Investigations into Use of a Native Sea Urchin for Biological Control of an Invasive Alga

Tamar Cunha[6]

Historically, biological control of invasive species has presented the unfortunate challenge that species brought in to control the invader often become pests themselves. To avoid that problem, it is worth considering whether there are native species that have the potential to serve as control agents. In Kāneʻohe Bay, Oʻahu, introduced algae have become invasive and so abundant that they outcompete corals for space. Current stocks of herbivorous fishes eat these algae but have not prevented their spread or dominance. A native urchin, *Tripneustes gratilla*, readily consumes the nonnative algae in laboratory tests. To examine the potential of this herbivore to control invasive algae, such as *Gracilaria salicornia*, one must consider its consumption rate compared with growth rate of the alga, movements of the urchins relative to algal distribution, densities needed to clear an area of algae, and impact that such densities might have on the native benthic community. Initial results show that the urchins keep to the region of the reefs that contain the invasive macroalgae. They have also demonstrated consumption rates similar to or higher than those of herbivorous fishes on a variety of invasive algae. High densities of urchins are able to clear an area of *G. salicornia* in a few months, though lower densities may also be able to clear an area if given more time. What remains to be seen is the impact of high densities of these urchins on native benthic communities once the invasive algae are cleared away and whether grazing fishes alone will prevent or only slow reinvasion by the invasive algae.

Photoecological Strategies Influence Success of Invasive Seaweed *Eucheuma denticulatum* on Hawaiian Coral Reefs[7]

Meghan Dailer[8]

Eucheuma denticulatum is a highly invasive seaweed that has become an ecological dominant in Kāneʻohe Bay, Oʻahu, and represents a serious threat to Hawaiʻi's reef-building corals. This alga can form large three-dimensional mats that overtop other reef organisms including corals. The success of this marine weed appears linked to the mat-forming morphology and ecophysiological adaptations that allow it to be competitively dominant in these reef environments. Specifically, fine-scale gradients in pigmentation have been observed and appear to allow *E. denticulatum* to grow under a wide range of light environments. The upper-canopy layer of algal tissue can receive irradiance levels more than 10-fold higher than does the understory. This study evaluated the differences in photochemical properties between the canopy and understory tissue in *E. denticulatum* and the rapid photoacclimation responses of these mat regions to changing light environments. The results suggest that different tissues of *E. denticulatum* have marked differences in photochemical properties and that the alga is capable of photoacclimating to both higher and lower irradiances within 6 days, a rapid response consistent with the invasive success of *E. denticulatum*.

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On Global Estimates of Vertical Mixing in the Ocean

Thomas Decloedt[9]

Stratification in the deep ocean is maintained by a combination of ventilation at isopycnal outcrops and diapycnal mixing. For the abyssal interior at mid- to low latitudes, diapycnal mixing is believed by many to be the dominant process maintaining the deep stratification against the influx of very cold water injected into the deep ocean at polar latitudes. Yet, direct measurements and inferred estimates of turbulence in the ocean's interior are well below what is required by the simple advection-diffusion models for maintenance of the stratification. This fact has rekindled interest in the idea that intense localized mixing at boundaries may play an important role in basin-average estimates of vertical mixing. This work examined some of the factors affecting extrapolation of the sparse estimates of near-boundary diapycnal diffusivities to global average diffusivities. In light of recent measurements of near-boundary turbulence and availability of high-resolution bathymetric maps, Armi's semiempirical model to estimate basin-average diffusivities was reexamined. Such basin averages have been estimated by a number of authors with often negative results, seeming to disprove the hypothesis of the importance of near-boundary mixing. These estimates were usually based on low-resolution bathymetry, however, and a prescribed structure of the mixing intensity that only varies in the vertical direction. It is shown in this work that the use of higher resolution bathymetry and a more careful, empirically obtained structure of mixing in both horizontal and vertical directions near topography yields increased basin-average diffusivities.

Phylogeny and Evolution of *Plantago* (Plantaginaceae) in the Hawaiian Islands

Stephanie Dunbar[10]

The genus *Plantago* is represented by three endemic species and four varieties in the most recent treatment of the Hawaiian flora. The Hawaiian *Plantago* are morphologically highly variable, and unique combinations of characters have led to a number of species and variety descriptions within the group by various authors in the past. The utility of 26 morphological characters as a tool for phylogeny reconstruction at the species level was investigated on 19 populations in this group. This phylogenetic analysis produced seven equally most parsimonious trees. Results from phylogenetic analysis of morphological characters are congruent with findings from nuclear rDNA internal transcribed spacer (ITS) sequence data that support the monophyly of the group and place its origins with a western North American ancestor in *Plantago* section *Plantago*. Phylogenetic analyses support the distinctiveness of the *P. princeps* and *P. pachyphylla* complexes and the paraphyly of *P. hawaiensis*. When used in combination with fast-evolving molecular markers, morphological data may be a valuable tool for phylogenetic studies in Hawaiian *Plantago*.

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Identifying and Characterizing Molecular Markers within the Genome of the Walnut Husk Fly, *Rhagoletis completa*[11]

Malia Eischen[12]

Currently there are a number of limitations on use of morphological characters for species identification. This is especially true for species such as those in the genus *Rhagoletis*, where a number of questions about speciation events remain unresolved. Use of molecular techniques for species identification may provide valuable alternative approaches. To date, very little if any molecular work has been reported for *Rhagoletis completa*, the walnut husk fly. This species is an agricultural pest that severely damages black walnut crops in California, and it may be part of a complex of closely related species. I have identified several molecular markers that may be used for species identification within this genus. Sequences of noncoding regions including internal transcribed spacer (ITS) regions of the rDNA and introns of two actin genes have been analyzed. These noncoding regions were chosen because of their propensity to harbor genetic variation even between closely related populations. Although further work must be done, using both the ITS regions and the introns of actin could prove to be sufficient for species identification of *R. completa*.

Genetic Population Structure and Phylogeography of Vermetid Gastropods in Hawai'i

Anuschka Faucci[13]

Many marine organisms have a high dispersal potential especially during their larval stage. Population genetic data can be used as an indirect measure of realized larval dispersal. Studies correlating genetic differentiation with life history traits such as dispersal ability have shown that, in general, high dispersal potential is associated with lack of genetic differentiation among populations. However, there are exceptions to this simple rule due to case-specific biological and physical reasons. Vermetids or wormsnails are sessile, suspension-feeding gastropods found in shallow marine waters. They show a wide range of developmental patterns from obligate, pelagic planktotrophic larvae, which reside in the plankton for several weeks, to species with direct developing benthic juveniles, which lack a planktonic phase. The Vermetidae in Hawai'i comprise nine species. Most species are locally abundant and distributed throughout the Hawaiian Archipelago. A 569–base pair region of the mitochondrial gene cytochrome oxidase I (COI) and a 319–base pair region of the nuclear gene Histone 3 (H3) were sequenced for the nine species from most Hawaiian Islands, including the Northwestern Hawaiian Islands. Species with direct development show highly structured populations throughout the Hawaiian Archipelago, suggesting very limited to no dispersal among islands. Furthermore, the vermetids appear to have colonized the Hawaiian Islands via the hypothesized French Frigate Shoals–Johnston Atoll connection, with a subsequent radiation into the remainder of the archipelago.

[11] Additional thanks are extended to Susan Opp from California State University, Hayward, for supplying the organisms for study.

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Effects of Artificial Reefs on Marine Benthic Communities in Hawai'i

Atsuko Fukunaga[14]

Deployment of artificial reefs has the potential for causing hydrographical and biological changes in the areas. Introduced human-made structures may also alter natural sand bottom communities by entrapping drift algae and other organic material, leading to the buildup of organics in the sediments. Sediment samples were collected in Māmala Bay, O'ahu, Hawai'i, from a natural reef (100′ hole) and two artificial reefs (Sea Tiger and YO257). The Sea Tiger artificial reef is a 51-m fishing vessel that lies perpendicular to the currents, and the YO257 artificial reef is a 53-m oiler that lies parallel to the current. Infaunal data from the artificial reefs and the natural reef were compared to examine any effects of the artificial reefs on marine benthic communities. The infaunal data showed that the three study sites were dominated by different invertebrate taxa. Nematodes were most abundant at the Sea Tiger artificial reef, polychaetes at the YO257 artificial reef, and crustaceans at the 100′ hole natural reef. Amphipod crustaceans are sensitive to a variety of toxicants and pollutants, and they were least abundant at the Sea Tiger artificial reef. Any polychaetes that thrive in sediments with a high level of organics were not abundant at any of the study sites. However, multidimensional scaling of the polychaete abundance data showed some separation of the study sites. The Sea Tiger artificial reef was represented mainly by detritivores and omnivores, the 100′ hole natural reef by carnivores and omnivores, and the YO257 artificial reef by omnivores. The high abundance of nematodes and detritivorous polychaetes and the low abundance of amphipod crustaceans may be an indication of moderate organic enrichment around the Sea Tiger artificial reef.

Trends in Ecosystem-Based Fishery Management for the U.S. Western Pacific Region

James M. Hawhee[15]

In recent years, the paradigm of ecosystem-based fisheries management has been discussed as an alternate or supplemental approach to more traditional single-species management techniques. Though an ecosystem approach seems promising, many technical and policy issues remain unresolved. One such issue involves designation of appropriate indicators to provide insight into the general health of the ecosystem being managed. Scores of indicators have been suggested, both internal and external to regional fisheries. A trophic-level analysis of regional coral reef fisheries will allow for use of readily available data to pursue the efficacy of some relevant ecosystem indicators and related reference points. It also provides a means to study historical top-down fishing influences, and it may be used to assess prevalence and degree of ecosystem overfishing within the region. Presented is a discussion of initial efforts to compile and analyze historical coral reef fishery data in the U.S. Western Pacific Region to study its potential for enhancement of ecosystem-based management.

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Role of Bacteria in Settlement of *Hydroides elegans*

Ying Huang[16]

Competent larvae of *Hydroides elegans* can be induced to settle and rapidly metamorphose by the presence of a well-developed biofilm or some single strains of biofilm bacteria. One bacterial strain, isolated from a sea table at Kewalo Marine Laboratory, *Pseudoalteromonas luteoviolacea*, induces settlement in most larvae of *H. elegans*, but *Flexibacter maritimus*, another sea-table species, induces no settlement of *H. elegans* larvae. Often laboratories have interpreted absence of settlement on single-bacterial films as evidence of inhibition. In this study it was determined that settlement frequency of *H. elegans* on a biofilm formed by mixing *F. maritimus* and *P. luteoviolacea* was not significantly different than that on a biofilm of *P. luteoviolace* alone. In addition, when cesium chloride was used to induce settlement and metamorphosis of *H. elegans* on a *F. maritimus* biofilm, settlement frequency was as high as that on surfaces without a biofilm, indicating that *F. maritimus* does not inhibit settlement and metamorphosis of *H. elegans*. Thus, settlement and metamorphosis of larvae of *H. elegans* on marine surfaces appear to kernel from positive bacterial cues and not avoidance of negative cues.

Determining Relationship between Biomass of Herbivorous Fishes and Benthic Cover on Coral Reefs

Danielle Jayewardene[17]

Over a hundred studies have shown that Marine Protected Areas (MPAs) enhance the abundance and size of fishes. Yet few studies have looked at direct and indirect effects of MPAs and their protection of fish on the coral reef system as a whole. I addressed this question by assessing the relationship between biomass of herbivorous fishes found on reefs with ranging levels of protection in Hawai'i and benthic cover of coral, macroalgae, and turf and crustose coralline algae. These benthic factors each reflect important ecological processes commonly occurring within reef ecosystems. Percentage cover for each factor at each site was determined by taking and analyzing photoquadrats. Very little macroalgae was found at all study sites (0–2.5%), eroding the ability to detect a relationship between biomass of the herbivorous fishes and macroalgal cover. Coral cover (25–58%), turf cover (20–48%), and crustose coralline algae cover (3–28%) differed significantly between sites. However, only crustose coralline algae cover showed a significant relationship with the biomass of herbivorous fishes. This trend was positive, indicating that herbivorous fish promote prevalence of crustose coralline algae on Hawaiian coral reefs.

Invasive Land-Snail Community Structure: Distributions and Associations of Species along Environmental Gradients on the Island of Hawai'i

Wallace Meyer[18]

Land-snail communities along three transects that run from sea level to 2,000 m in elevation were investigated on the island of Hawai'i in February, July, and December 2004. Extant native diversity in this area consists of three species of Succineidae and five species of

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"tornatellinids" (small Achatinellidae belonging to a subfamily other than Achatinellinae). Unfortunately, the majority (14 species) of the current land-snail fauna is composed of introduced species. Cluster analysis examining the introduced fauna shows only three major community groupings: those inhabiting low elevations (0–500 m), mid elevations (750–1,000 m), and high elevations (1,250–2,000 m). The low-elevation community consists primarily of species introduced from tropical regions, and species associated with mid and high elevation are primarily from temperate regions. Multidimensional scaling (MDS) and analysis of similarity (ANOSIM) revealed that these community patterns were correlated with elevation, canopy tree species, and ecosystem type; however, because there are strong correlations among all of these variables, the direct cause of the community associations cannot be determined. Mean average rainfall was a poor indicator of community structure. These results have management significance because many of the native species are found at higher elevations and thus will likely be affected by introduced species from temperate climates.

Spatial Patterns of Coral Reef Fishes in the Central Pacific

Craig Musburger[19]

An ongoing study is being conducted to investigate large-scale geographic patterns of distribution of shallow-water coral reef fishes of the central Pacific Ocean. Over the past 3 yr, I have collected species-level quantitative and qualitative data concerning the distribution of coral reef fishes from 19 islands and atolls in the Marshall Islands, American Samoa, the Line Islands, and the Northwestern Hawaiian Islands. All data used are visual census data collected while on scuba or snorkeling. Multivariate cluster analysis is being used to evaluate the similarity between island groups and between individual sites. The methodologies being used for the project as well as some preliminary results are presented here. Data covering all taxa of reef fish observed at each location are being used in the spatial analysis. Special emphasis is being placed on the pomacentrids in this study because they are abundant and diverse at all locations surveyed.

Endosperm Removal Enhances Germination of Two Rare Hawaiian Palms (*Pritchardia*, Arecaceae): Implications for Seed Predation[20]

Hector E. Pérez[21]

In Hawai'i, introduced rats are implicated as primary consumers of *Pritchardia* seeds and anecdotally linked to recruitment failure. Middens of partially eaten fruits and seeds have been found within wild *Pritchardia* populations. However, it is not known to what extent damaged propagules retain the ability to germinate and establish. We tested the effect of endosperm removal on germination of two rare, endemic Hawaiian palms: *P. hillebrandii* and *P. kaalae*. Low (12.9% by volume) to moderate (42.5%) endosperm removal increased germination up to 14% over controls. However, high (75.2%) endosperm removal decreased germination by 28 and 78% for *P. hillebrandii* and *P. kaalae*, respectively. Treated seeds germinated twice as fast as

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those in the controls. Thus, limited damage may facilitate recruitment by breaking dormancy and increasing the speed of germination, whereas extensive damage prevents germination. Alternatively, fungal pathogens or inadequate soil moisture may kill damaged seeds or seedlings.

Antibody-Mediated Inhibition of *Plasmodium falciparum* Growth

Jennifer A. Seki[22]

Malaria resulting from infection by the parasite *Plasmodium falciparum* is a serious and potentially fatal disease, posing a major public health problem, especially in developing countries where it is endemic. Research toward development of a malaria vaccine is currently being conducted in several laboratories around the world, using various approaches and techniques. We have focused on targeting the malaria parasite in the merozoite stage of its life cycle, specifically its surface coat proteins. Merozoite Surface Protein 1 (MSP-1) and its processing fragments are believed to be involved in facilitating entry of the merozoite into host cells. An MSP-1 antigen construct corresponding to the C-terminal region of the MSP-1 precursor polypeptide produced in the baculovirus expression system was used to immunize rabbits in combination with Complete and Incomplete Freund's Adjuvant. Polyclonal antibodies were isolated from preimmune and immune rabbit sera and tested for their effect on in vitro *P. falciparum* growth. Several sera from rabbits immunized with MSP-1 antigen were found to inhibit parasite growth in human red blood cell cultures. These sera will be further analyzed to determine the potential relationship of growth inhibition to antibody titer by ELISA and IFA and to antibody specificity for conserved versus nonconserved MSP-1 epitopes. These studies will assist in the evaluation of baculovirus MSP-1 as a potential blood-stage malaria vaccine.

Effects of Environmental Factors on Differential Reproductive Timing of Gametophyte and Sporophyte Life Phases of *Ulva fasciata*

Masaya Tanaka[23]

Reproductive ecology of the green alga *Ulva fasciata* on Hawai'i's rocky intertidal shores is poorly understood compared with studies in other areas. Hawai'i's unique tropical environmental factors, including small tidal range, small seasonal water temperature fluctuations, and high irradiance levels year-round, contribute different reproductive patterns with respect to other areas. The alternate life history of *U. fasciata* consists of two entities, gametophyte and sporophyte, which release gametes or spores to complete a full life cycle. I tested several hypotheses of the timing of release of reproductive cells of *U. fasciata* concerning environmental factors, such as irradiance level, lunar cycle, tide phase, salinity, and water temperature, in the intertidal zone along the rock wall on the Ala Wai Canal side of Ala Moana Beach Park, O'ahu, Hawai'i. The good agreement between the differential timing of gametes/spores release and tide phase/irradiance levels suggests that desiccation/reflooding regimes and periods/intensity of irradiance are both cues and decide the timing of reproductive cell release.

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Medicinal Plant Usage and Perceptions in El Verde, Puerto Rico[24]

Laura Weiss[25]

The Caribbean island of Puerto Rico is culturally rich and diverse. Rapid urbanization and westernization, however, may threaten local traditions in this U.S. commonwealth. This study sought to record medicinal plant knowledge in El Verde, Puerto Rico, a rural montane tropical town facing major demographic changes and encroaching development. In total 45 community members native to Puerto Rico were interviewed, predominantly in Spanish, with male and female subjects ranging in age from 19 to 100 yr old. Subjects were asked about their personal use of medicinal plants, as well as their opinions and possible explanations for changes in medicinal plant usage in El Verde. A total of 89 plants was acknowledged in open-ended interviews, up to 40 of which were employed in subsequent semistructured interviews. Subjects described plant remedies for treatment of many ailments, including common colds, urinary tract complaints, diabetes, and cancer. Most subjects felt that medicinal plant usage has declined, mainly due to economic forces related to westernization and modern medicine. Plant-tending practices and perceptions of the forest were also explored.

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